

1           1.     A method for controlling a physical dimension of a solid state  
2 structural feature comprising the steps of:  
3           providing a solid state structure having a surface and having a  
4 structural feature;  
5           exposing the structure to a periodic flux of ions having a characteristic  
6 ion exposure duty cycle, at a first exposure temperature; and  
7           exposing the structure to the periodic flux of ions at a second exposure  
8 temperature that is greater than the first exposure temperature, to cause  
9 transport, within the structure including the structure surface, of material of  
10 the structure to the structural feature in response to the ion flux exposure to  
11 change at least one physical dimension of the feature substantially by locally  
12 adding material of the structure to the feature.

1           2.     A method for controlling a physical dimension of a solid state  
2 structural feature comprising the steps of:  
3           providing a solid state structure having a surface and having a  
4 structural feature;  
5           exposing the structure to a periodic flux of ions having a characteristic  
6 ion exposure duty cycle, at a first ion flux; and  
7           exposing the structure to the periodic flux of ions at a second ion flux  
8 that is less than the first ion flux, to cause transport, within the structure  
9 including the structure surface, of material of the structure to the structural  
10 feature in response to the ion flux exposure to change at least one physical  
11 dimension of the feature substantially by locally adding material of the  
12 structure to the feature.

1           3.     A method for controlling a physical dimension of a solid state  
2 structural feature comprising the steps of:

3            providing a solid state structure having a surface and having a  
4            structural feature;  
5            exposing the structure to a periodic flux of ions having a first exposure  
6            duty cycle characterized by a first ion exposure duration and a first  
7            nonexposure duration for the first duty cycle; and  
8            exposing the structure to a periodic flux of ions having a second  
9            exposure duty cycle characterized by a second ion exposure duration and a  
10           second nonexposure duration, greater than the first nonexposure duration,  
11           for the second duty cycle, to cause transport, within the structure including  
12           the structure surface, of material of the structure to the structural feature in  
13           response to the ion flux exposure to change at least one physical dimension of  
14           the feature substantially by locally adding material of the structure to the  
15           feature.

1           4.     A method for controlling a physical dimension of a solid state  
2           structural feature comprising the steps of:

3           providing a solid state structure having a surface and having a  
4           structural feature;

5           exposing the structure to a continuous flux of ions; and

6           exposing the structure to a periodic flux of ions having a duty cycle  
7           characterized by an ion exposure duration and a nonexposure duration for  
8           the duty cycle, to cause transport, within the structure including the  
9           structure surface, of material of the structure to the structural feature in  
10           response to the ion flux exposure to change at least one physical dimension of  
11           the feature substantially by locally adding material of the structure to the  
12           feature.

1           5.     The method of any of claims 1-4 wherein the structural feature  
2           comprises an aperture.

1           6.     The method of any of claims 1-4 wherein the structure comprises  
2     a crystalline substrate.

1           7.     The method of any of claims 1-4 wherein the structure comprises  
2     a silicon nitride membrane.

1           8.     The method of any of claims 1-4 wherein the structure comprises  
2     a silicon dioxide membrane.

1           9.     The method of any of claims 1-4 wherein each periodic flux of  
2     ions comprises an ion flux duty cycle of at least about 50%.

1           10.    A method for controlling a physical dimension of a solid state  
2     structural feature comprising the steps of:  
3           providing a silicon dioxide membrane having a structural feature; and  
4           exposing the silicon dioxide membrane to a periodic flux of ions having  
5     a duty cycle characterized by an ion exposure duration and a nonexposure  
6     duration for the duty cycle, to cause transport, within the silicon dioxide  
7     membrane including the membrane surface, of material of the membrane to  
8     the structural feature in response to the ion flux exposure to change at least  
9     one physical dimension of the feature substantially by locally adding  
10    material of the membrane to the feature.

1           11.    The method of claim 10 wherein the feature comprises an  
2     aperture in the membrane.

1           12.    A method for controlling area of an aperture in a structure  
2     comprising the steps of:

providing a solid state structure having a surface and having an aperture in the structure extending from the surface; and exposing the structure to a periodic flux of ions having an ion exposure duty cycle characterized by an ion exposure duration,  $T_{on}$ , and a nonexposure duration,  $T_{off}$ , together selected to cause transport, within the structure including the structure surface, of material of the structure to an edge of the aperture in response to the ion flux exposure substantially by locally adding material of the structure to the aperture edge, the ion exposure and nonexposure durations being selected based on:

$$\frac{dA}{dt} = R_{ss} \left( 1 - e^{-\frac{t}{\tau_{rise}}} \left( \frac{1 - e^{-\frac{T_{off}}{\tau_{decay}}}}{1 - e^{-\frac{T_{off}}{\tau_{decay}} - \frac{T_{on}}{\tau_{rise}}}} \right) \right) \quad 0 \leq t < T_{on} \quad (1a)$$

$$\frac{dA}{dt} = R_{ss} \left( 1 - e^{-\frac{T_{on}}{\tau_{rise}}} \left( \frac{1 - e^{-\frac{T_{off}}{\tau_{decay}}}}{1 - e^{-\frac{T_{off}}{\tau_{decay}} - \frac{T_{on}}{\tau_{rise}}}} \right) \right) e^{-\frac{(t-T_{on})}{\tau_{decay}}} \quad T_{on} \leq t \leq T_{off} \quad (1b)$$

where  $t$  is time,  $dA/dt$  is a selected rate of change in aperture area,  $A$ ;  $R_{ss}$  is a steady state rate of aperture area change characteristic of the structure for continuous ion flux exposure; and  $\tau_{rise}$  is a material response rise time and  $\tau_{decay}$  is a material response decay time characteristic of the structure under ion exposure.